Advantages and Disadvantages of Nuclear Energy

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Thesis: Although it has some dangers, nuclear energy is a useful energy type due to being economical and environmentally-friendly.

I. Dangers of nuclear energy

A. Directly effective on humans

1. Radiation

2. Terrorism

a. Nuclear weapon

b. Vulnerability to terror attacks

B. Indirectly effective on humans

1. Accident

2. Nuclear waste

II. Economical aspect of nuclear energy

A. Preproduction

1. Cheap raw material

2. Large reserves

B. Production

1. Huge energy capacity

2. Long life time

3. Payback time

III. Environmental aspect of nuclear energy

A. Air

1. Greenhouse gas emissions

2. Climate change

B. Soil

1. Lower radiation

2. Waste management

From past till present day, significantly in the 18th and 19th centruies when the Industrial Revolution happened, energy have become an obligation to use most of the technology in the world. However, nowadays not only the petroluem or fossil sources, but also alternative energy sources are widely-used. Most alternative energy sources are environmentally-friendly. Moreover, right along with being environmentally-friendly, the alternative energy sources also supply very high energies. What is more, one alternative energy source has a very micro level raw material which can also be called as atomic particles. This energy source is named as nuclear energy. Nuclear energy is a considerable energy source that is obtained from the nucleous of atom. "It is a clean energy source, capable of providing substantial quantities of electricity at a competitive and stable cost and small volumes of waste it does produce can be well isolated from the environment" (Rougau, 1997, pp. 129-131). Although it has some dangers, nuclear energy is a useful energy type due to being economical and environmental-friendly.

The first remarkable disadvantage of nuclear energy is the reality that it has some minor dangers. To begin with, nuclear energy may harm people directly in the short term. Most importantly the radiation it emits causes negative effects on humans. As research by Cohen (n.d.) shows, if subatomic particles from radiation enter to human body, the cells on the body can be damaged. Moreover, if the sex cells, which are important for creating feature generation, are damaged, a hereditary disorder can happen. Nuclear power plants manufacture materials that release radiation which makes their name "radioactive". Normally, innate radiation engender about 1% of cancers; however, 0.002% ascension caused by nuclear technology makes the 1%, 1.002%. This decreases, furthermore, the life of humans about an

hour (“Radiation” section para. 1, 3). Actually, despite the fact that nuclear technology makes cancer, normal radiation causes cancer 500 times as much as nuclear technology. Taking this into consideration, one can say that humans should avoid from nuclear facilities to take care of themselves. Dunstan states that during normal nuclear power operation, radiation is released. There are, however, standards that are determined by International Commission of Radiological Protection. Although there are releases on regular operations, these releases are authorised and administrated by national regulation and internationally affirmed standards of exposure. On the other hand, indirectly, radiation can also be caused from uranium mining. In fact, mining has already caused some environmental damnum since past times. For example, radioactive gas, radioactive powder or other radioactive materials can be released from mining. What is more, by not taking rigorous measures, many miners died as yet and it is increasing also. Per contra, it is obvious that nuclear power is not the biggest source of the radiation (2002, pp. 21, 22). In spite of the fact that nuclear energy is really dangerous and releases radiation unless rigorous measures are taken, it is not the largest reason of radiation. In the world, there are much more dangerous power plants such as coal fired power plants. On account of all these facts, one can conclude that in nuclear technology area, such as nuclear power plants, taking serious precautions need to become an obligation. Moreover, nuclear energy has a terrorism risk due to its usage while producing nuclear weapons and the probability of terrorist attacks to nuclear power plants. As Blair explains, radiological dispersion bomb which is composed of nuclear waste material radiates dangerous radioactive molecules during its explosion. This kind of bomb is easily reachable as the protection of nuclear waste is not so much good as general nuclear weapons. As an example in Russia, in 1996 Chechen terrorists tried using radiological dispersion bomb to prove Russia’s inability

but the bomb did not blow up. Another sample is gamma-ray emitting bombs, which are the combination of dynamite and nuclear waste. It is calculated as thousands people will be poisoned and more than 2000 people will die if such a bomb is detonated in Manhattan at noon (2001, "A Dirty Bomb" section, para. 1-4). Considering the information above, one can say that governments should care about their security much more than before. As the study of Holt and Andrews shows, despite the fact that nuclear power plants are built by taking into consideration many events like earthquakes, floods and alike, air attacks are not considered during design. This kind of assault may result in meltdown and radiation scattering. There is another possibility that terrorists might attack the spent fuel storages which are outside of the buildings. If this event causes the disposal of cooling water, it leads to fire depending on overheating (2006, pp. 4-5). This implies that the design of nuclear power plants needs a wide revision to be protected from terrorists. It can be concluded that nuclear energy has some handicaps which affect people directly.

Apart from its direct effects, nuclear energy also affects humans indirectly. As an example, accidents in nuclear power plants damaged the environment and harm people in the long term. Lai and Morrisson explain that there was an accident in Chernobyl power plant in 1986. There were some serious consequences of this event. For example, immediately, the accident caused the death of 30 people, 28 of them were subjected to radiation. In addition, there were more than 209 people who were cured from acute radiation poison, and finally the accident was the reason for thousand of cancer-related deaths. Another catastrophic accident of power plants was experienced in Three Mile Island in 1979 because of equipment failures and human errors. People who lived in this area suffered from thyroid cancer and also the

number of plant mutation increased dramatically (n.d., “Risk of Accidents” section, para. 1-2). In the light of these examples, it can be said that people should be more careful when producing energy from nuclear power. In addition, nuclear waste from nuclear fuel may result in harmful impacts on all living creatures. Caldicott states that if the radioactive waste is stored, it will cause some troubles. It is known that the reactor core includes radioactive material but cooling pools at nuclear reactors consist of 10 to 30 times more. Cooling pools are susceptible to nuclear waste which affect human body biologically in a high level and are most likely to cause cancer and genetic diseases. The time for the radiation to cause cancer ranges from five to 50 years. Iodine 131 which keeps up its radioactivity up to 6 weeks gather in leafy vegetables and milk. After it comes into human body, it is collected in the neck where it leads to thyroid cancer. Strontium 90 keeps its effect for 600 years and it results in breast cancer, bone cancer and leukemia by gathering and increasing in the human breast in the time of lactation. Another element lasting for 600 years is Cesium 137. It settles in muscle in which it creates fatal muscle cancer, sarcoma. Even one-millionth of a gram of Plutonium can cause cancer and every 1000 mega watt nuclear power plant produces over 200 kilograms of it. Therefore, it is one of the most hazardous elements. It has a direct impact to generate cancers, some common ones of which are liver cancer, bone cancer, lung cancer and testicular cancer. In addition, it contributes to blood malignancies and serious congenital deformities. Plutonium endures for 500.000 years during this time, both causing cancers and genetic diseases which pass from one generation to another of humans, plants, animals. Plutonium is a kind of fuel that can be used in the production of nuclear weapons. Every reactor induces annually over 200 kilograms of Plutonium, just 5 kilogram of which can, for instance, be useful for having a bomb. In the light of this example, each country can produce 40 bombs a

year because of nuclear power plant (2005, para. 16-25). Considering the information above, are can conclude that the energy released from nuclear waste can be very dangerous. Consequently, dangers of nuclear energy are clear.

Another significant superiority of nuclear energy is its economical aspect. In the first place, it has a splendid effect on economy before the production. As an example, the raw material used is the cheapest which is a major benefit for the economy. Barry states that uranium is not an expensive fuel yet. Moreover, it is really amazing when noticed that, as energy, 80,000 barrels of oil or 16,000 tons of coal is equal to a ton of uranium, which means that, for instance, oil is sixty times more expensive than uranium at this time. On the other hand, uranium is a few percent of cost construction, and unless prices do not change significantly, the affordability of electricity will be the same. Furthermore, according to the U.S. government numbers, spot uranium, which is now $71, was much higher than today; which was $143.51 in 1978 (2008, “Uranium is Still a Very Cheap Fuel” section, para. 1, 3). In fact, from the numbers, it can be realized that rather than the other energy sources, uranium is a very cheap energy source and it is cheaper now. Thus, for inexpensive energy, uranium is a remarkable energy source that should be chosen. As Risto and Aija explain, when alternative energy types’ costs are analyzed, it can be seen that the lowest cost equals 35.00 €/MWh, which is the cost of nuclear power. In addition, it is €8.60 cheaper than the closest cost price, which is peat power’s; 43.60 €/MWh . Furthermore, the nuclear power’s cost is also lower than the cost of wind electricity (€17.9 lower), the cost of wood power (€38.6 lower), the cost of coal power (€10.7 lower), and even the cost of gas power (€16.2 lower) (See Figure 1) (2008, p. 8). As it is clear from these examples, one can say that the cost of nuclear power is

much cheaper than the others. For this reason, unless the energy sources keep being used, the prices of electricity will not go down; on the other hand, nuclear energy can make the prices lower. Moreover, as known, the larger the reserves the cheaper the material and the uranium and the plutonium reserves are abundant all over the world, which makes the reserves of nuclear energy cheap. World Nuclear Association reports that there is a lot of uranium in rocks and seawater because of its prevalence. Australia has 1,673,000 tones, Kazakhstan has 651,000 tones, and Canada has 485,000 tones uranium. Totally, there are 5,404,000 tons of uranium all over the world (See Table 1). 68,000 tons of uranium are used every year. These amounts of uranium suffice for about 80 years. When all resources are thought, 5, 5 million tons of uranium are enough for about 160 years. The level of other elements which are obtained from resources is not as high as uranium. Since research exploration booted, the number of uranium research has been rising for 35 years (See Figure 2). Another source is recycled uranium and plutonium. It maintains the supply of 1500-2000 tons of uranium per year. Another method is using fissile material, which is produced from fuelcyle. After the neutron is enclosed in fissile thorium, thorium changes into fissile uranium. 3, 6 tones of it were produced by thorium (2010, para. 1-26). Taking all these facts into account, it is clear that one of the common metals is uranium, and there are many uranium reserves all over the world. Research thus shows that nuclear energy has many economic aspects.

In addition to preproduction benefits of nuclear energy, it is also economical in the course of the production. One of the reason for this is the fact that nuclear energy has a huge energy capacity. Kohl states that 1 kg firewood creates 1kwh of electricity and 1 kg of coal or oil will produce approximately 4 kwh of electricity whereas 1 kg of uranium reveals 50.000

kwh of electricity (2009, para. 7-9). Considering the information above, one can conclude that nuclear energy is more economical than the other energy type. World Nuclear Association reports that uranium with a sufficient amount is not as much as the coal and fuel. To illustrate, 1 kg natural uranium has 20.000 times more energy than the others due to the fact that it is a substance that is movable and can be traded. When the committed energy is rescued, much more energy can be ensured (2010, "The Cost of Fuel" section, para. 5-7). Objectively speaking, one cannot deny the fact that nuclear energy provides much more energy by using less of its proportion. Furthermore, nuclear power plants are used for a long life time. As the study of Risto and Aija's documents, nuclear power's economic lifetime is 40 years while this time is 25 years for the other powers. If nuclear energy's economic lifetime was 25 years, electricity generation cost would 4€ higher than now for per megawatt hour which does not much change the truth that nuclear energy is the most advantageous energy economically (Risto & Aija, 2008, p. 15). This makes it clear that, nuclear energy is the energy type which should use for long times. What is more, in spite of its "long" life, the payback time of nuclear energy is not longer than expected. As Risto and Aija explain, 4125 million euro is the beginning expense amount for a 1500 MW output capacity. Payback time for the initial investment is 40 years in the situation selling the production at 35€/MWh (see Figure 3). If the market price for electricity is 50€/MWh, then the payback time decreases to 14 years. And 60€/MWh electricity sale price is payback the initial investment cost 4125 million euro just in 10 years (See Figure 4) (2008, pp. 17-20). Taking this into consideration, one can conclude that nuclear energy is economically efficient as it repays its cost fast compared to its economic lifetime. All these examples prove that nuclear energy has many economic benefits.

The final remarkable benefit of nuclear energy is the fact that it is environmentally-friendly.First of all, nuclear energy helps to keep the air clean. Most importantly, it reduces greenhouse gas emissions.Rougeau (1997) asserts that the goal of European Union was to decrease the level of greenhouse gas emission about 15% between 1990 and 2010. Like European Union, Japan has also targeted to reduce the emission of green gasses by 5% at the same process. Nuclear power reduces about 2.3 billion tons of CO_2 emission annually. Just in Europe, it decreases CO_2 emission every year about 700Mt. However, a 1000MW coal power generates about 6.5Mt CO_2 in a year. Moreover, nuclear power does not create other greenhouse gases, two of which are NO_x and SO_2 (pp. 129-131). As it is clear from these examples, one can say that nuclear power prevents greenhouse gas emissions. As Nuclear Energy Institute pointed out in 2009:

> Nuclear energy has played a major role in reducing U.S. emissions of carbon dioxide, sulfur dioxide and nitrogen oxides by substituting for fossil fuels that otherwise would have been burned to generate electricity. The 104 nuclear power plants operating in 31 states provide electricity for one in five homes and businesses without emitting carbon dioxide, the major greenhouse gas. In fact, nuclear energy provides 72 percent of the electricity that comes from emission-free sources, which also include renewable technologies and hydroelectric power plants. (pp. 1, 2)

This would indicate that nuclear energy should be used instead of other energy sources. International Nuclear Societies Council reports that in nuclear power greenhouse gases and gases that result in acid rain do not occur. 1300MW nuclear power plant prevents the emission of 10 million tones CO_2, 1400t SO_2 and 7000t NO_x and occurring 2300t particulars, compared

to same sized coal power plant. 25 billion tons of CO_2 is produced by using fossil fuels per year. Nuclear energy averts 2.5 billion tons of CO_2 annually which corresponds to 10% of total CO_2 emissions (See Table 2) (2002, pp. 5, 19-21). For this reason, if countries do not show enough importance to nuclear power, there will be high damages on the environment. In addition, nuclear energy does not contribute to climate change. As Nuclear Energy Institute pointed out, U.S policymakers use legislative and other methods to decrease greenhouse gas emissions. The role of nuclear energy to reduce carbon dioxide is obvious. The whole analyses display that to diminish carbon emissions will call for a compilation of technologies which nuclear energy must be a part of. Energy legislation made by Obama administration on climate change legislation is still debated. American Clean Energy and Security Act was acknowledged by the House of Representives. It involved several obligation suborting nuclear energy. Analyses of H.R. 2454 by EPA and U.S. Energy Information Administration (EIA) show that rising nuclear energy generating capacity will help legislation's carbon-reduction goals. Between 2010 and 2050 nuclear generation will go up about 150 percent from 782 billion kilowatt hours to 2,081 billionkwh. As long as all presence of U.S. nuclear power plants finishes until 2050, 187 new nuclear power plants must be constructed (2009, pp. 1, 2). Research thus shows that greenhouse gases cause climate change and nuclear energy should be used to reduce the climate change. As Milliband pointed out in 2009:

> The reactor should meet at least a quarter of electricity demand by 2025. New nuclear is right for energy security and climate change and will be good for jobs too. The threat of climate change means we need to make a transition from a system that relies

heavily on high-carbon fossil fuels to radically different system that includes nuclear, renewable and clean coal power. (pp 7, 8)

All things considered, it is obvious from the above that nuclear energy gains advantages from energy security and climate change. Clearly, nuclear energy is the best alternative to protect nature.

Besides providing clean air, nuclear energy does not threaten the soil with pollution, either.One of the reasons for this is the fact that nuclear energy creates low radiation.Eral, Aslan and Akyıl emphasized that according to the standards by Nuclear Regulatory Council (NRC), the upper limit of radiation for flue gases is 0,05 mSv/year for the whole body and 0.15 mSv/year for thyroid. This limit is 0.03 mSv/year for liquid waste. But in the implementation, 0.001 mSv/year for the whole body and 0.01 mSv/year for thyroid are emitted from nuclear power plants. Also, in England while the whole nuclear industry affects the environment with the 0.002 mSv/year radiation emitting per year, coal-fired power plants affect the environment with the 0.004 mSv/year radiation emitting annually (1997, p. 25).All these examples lead to the fact that the nuclear energy should be more preferred. Moreover, nuclear energy is the only energy type which has strict waste management rules.World Nuclear Association reports that the individual industry that takes the whole accountability of all its wastes from the industry, and includes these expenses into the product, is nuclear power. On the other hand, intermediate–level waste involves higher quantity of radioactivity and might necessitate especial covering. Normally, it encloses chemical sludge, resins and some components which are from the reactor. However, nuclear reactors counterbalances 7% of the volume and has 4% of the radioactivity of all radwaste. Usually, short–lived waste that

is from reactors mostly is kept underground, but waste which lingers longer that is from nuclear fuel which is reprocessed, will be brushed off of deep underground. Furthermore, fuel that is used forms high–level waste which is only 3% of all radwaste and has 95% radioactivity. While generating electricity from nuclear supplies, radioactive wastes appear at all the phases of the nuclear fuel cycle; such as, mining of uranium, processing, reprocessing, etc. “front end” and “back end” are the two parts of nuclear fuel cycle. The time between mining and using of uranium in the nuclear reactor is the “front end”; the replacement of used fuel, its economization and betterment are in the process of “back end”. To disassociate the used fuel chemically into uranium, plutonium and high–level waste solution, it needs to be reprocessed. Moreover, except 3% high–level waste of all used fuel, %97 can be recycled. “The recyclable portion is mostly uranium depleted to less than 1% U-235, with some plutonium, which is most valuable”. On the other hand, 1% high–level waste equals approximately 233 kg/year, which makes the 3% high–level waste almost 700 kg per year. What is more, this dangerous 700 kg high–level waste should be insulated for a very long time to protect the environment. Furthermore, it is clear that serious measures should be taken in a nuclear reactor because of the hazardous wastes (2007, para. 20-37).Considering the information above, one can conclude that the measures should not be taken only on processing of the nuclear fuel; also, the measures need to be taken after the process. At the same time, by recycling the used fuel, the risk of nuclear wastes can be significantly decreased (by approximately %97).Research thus shows that nuclear energy is not harmful to the environment as much as people think.

In conclusion, nuclear energy is an important energy source in the modern world. It becomes prominent with its some major features. In the first place, it involves some risks. Nuclear energy has negative effects on humans both directly and indirectly. The second significant characteristic of nuclear energy is its economic benefits not only in preproduction process, but also in production process. Finally, nuclear energy does not contaminate the environment. While it is advantageous for the air, it is also profitable for the soil. With all these specialties, the importance of nuclear energy will be understood by huge crowds. Therefore, the governments should show enough care to nuclear energy and avail from its benefits. Moreover, in the future when the Earth will need much more energy, it will be an obligation to make much research about nuclear energy, which will be more significant and required energy for humanity.

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Table 1.

Known Recoverable Resources of Uranium 2009

	Tonnes U	Percentage of world
Australia	1,673,000	31%
Kazakhstan	651,000	12%
Canada	485,000	9%
Russia	480,000	9%
South Africa	295,000	5%
Namibia	284,000	5%
Brazil	279,000	5%
Niger	272.000	5%
USA	207,000	4%
China	171,000	3%
Jordan	112,000	2%
Uzbekistan	111,000	2%
Ukraine	105,000	2%
Indi	80,000	1.5%
Mongolia	49,000	1%
other	150,000	3%
World total	5,404,000	

From “Supply of Uranium” by WNA 2010. Retrieved October, 20, 2010, from http://www.worldnuclear.org / info/inf75.html

Table 2.

CO_2 Emissions Worldwide

Emissions by the combustion of fossil fuels:
25 billion tons of CO_2 annually
World electricity production by nuclear power:
2248 TWh (net) 2000
16% of the total electricity generation
6% of total primary energy production
Amount of avoided CO_2 emissions due to the use of
nuclear power in 2000:
2.5 billion tons of CO_2
(10% of total CO_2 emissions)
Recommendation from the Toronto conference (1988):
Cut total annual emissions by 20% (4 billion tons of CO_2
up to 2005
Power sector:
CO_2 emissions: 8.5 billion tons of CO_2 (34%
of total emissions)
Avoided emissions due to the use of nuclear
power: 29% of total emissions of the power sector

From "Current issues in nuclear energy" by INSC 2002. Retrieved October 27, 2010, from http://www.ne.jp/asahi/mh/u/insc-power.pdf

Figure Captions

Figure 1. The electricity generation costs of the power plants, without emission trading.

Figure 2. The number of uranium research raises because of the fact that research exploration increase.

Figure 3. Payback diagram of the nuclear power plant investment at electricity sales price of 35 €/MWh.

Figure 4. Payback diagrams of the nuclear power plant investment at electricity sales prices of 35, 40, 45, 50 and 60 €/MWh (time scale of 20 years).